

## RESEARCH PAPER

# Smoking and erectile dysfunction: findings from a representative sample of Australian men

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**Objectives:** To examine whether there is an association between smoking and erectile dysfunction in a representative sample of Australian men.

**Design:** Secondary analysis of cross-sectional survey data from the Australian Study of Health and Relationships.

**Participants:** 8367 Australian men aged 16–59 years.

**Main outcome measures:** Erectile dysfunction was identified in men who reported having had trouble keeping an erection when they wanted to, a problem which persisted for at least one month over the previous year. Variables examined in multivariate logistic regression analyses included age, education, presence of cardiovascular disease and diabetes, and current alcohol and tobacco consumption.

**Results:** Almost one in 10 of the respondents (9.1%) reported erectile dysfunction that lasted for at least one month over the previous year. More than a quarter (27.2%) of respondents were current smokers, with 20.9% smoking  $\leq$  20 cigarettes per day, and 6.3% smoking  $>$  20 cigarettes per day. Compared with non-smokers, the adjusted odds ratios for erectile dysfunction were 1.24 (95% confidence interval (CI) 1.01 to 1.52,  $p = 0.04$ ) for those smoking  $\leq$  20 cigarettes per day and 1.39 (95% CI 1.05 to 1.83,  $p = 0.02$ ) for those smoking  $>$  20 cigarettes per day, after adjusting for other confounding factors. Older age, low level of education, and taking medications for cardiovascular disease were also independently and positively associated with erectile dysfunction. In contrast, moderate alcohol consumption (1–4 drinks per day) significantly reduced the likelihood of having erectile dysfunction.

**Conclusions:** Erectile dysfunction is a significant health concern affecting around one in 10 Australian men aged 16–59 years. Current smoking is significantly associated with erectile dysfunction in Australian males. This association was strengthened as the number of cigarettes smoked increased. Health promotion programmes could use the link between smoking and erectile dysfunction to help reduce smoking levels among men.

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Australian men are much more likely than women to be daily smokers (19% compared to 16%) with the highest smoking rate (24%) among those aged 20–29 years.<sup>1,2</sup> This younger group may be less receptive to conventional tobacco control messages, which typically focus on risks of potentially distant events such as cardiovascular disease and lung cancer. Evidence of a link between smoking and erectile dysfunction has been little used as a means of persuading male smokers to quit,<sup>3,4</sup> although recent tobacco control efforts in California have targeted young smokers with this message,<sup>5</sup> as have graphic cigarette pack warnings in Brazil and Thailand.<sup>6</sup>

Studies have suggested an association between smoking and erectile dysfunction. However, much of the accumulated evidence has been derived from clinical settings.<sup>7,8</sup> Very few population-based studies have examined this link and evidence supporting a causal relationship between smoking and erectile dysfunction remains limited. The Massachusetts Male Aging Study, a cohort study of men aged 40–70 years living in the Boston area, found that cigarette smoking at baseline almost doubled the likelihood of moderate or complete erectile dysfunction at follow-up, after controlling for other risk factors.<sup>9</sup> In another study, Mannino *et al*<sup>10</sup> reported that in a study of 4462 Vietnam war veterans aged 31–49 years, smokers were one and a half times more likely to report impotence than non-smokers. However, these findings were weakened by their selective study populations.

In this study we examined factors that are associated with erectile dysfunction in a large, representative sample of 8367 Australian men aged 16–59 years using data from the 2001

Australian Study of Health and Relationships (ASHR), a major national survey of sexual and reproductive health. Its study population was generated using modified random digit dialling telephone survey methodology for all the states of Australia.<sup>11</sup>

## METHODS

The ASHR was a major cross-sectional survey of a representative sample of adults aged 16–59 years covering a wide range of sexual and reproductive health issues. A total of 19 307 respondents (10 173 men, 9134 women) completed a computer-assisted telephone interview between mid-2001 and mid-2002. The response rate for men was 69%. Full details of the study methods have been described elsewhere.<sup>11</sup> The study protocol was approved by the Human Ethics Committees of La Trobe University, the University of New South Wales and the Central Sydney Area Health Service.

## Study sample and data collection

We analysed ASHR data for male respondents who reported being sexually active over the past 12 months, using a broad definition which covered sexual intercourse and masturbation. The study outcome variable was self-reported erectile dysfunction which was assessed using the question: "During the past year has there been a period of one month or more when you had trouble keeping an erection when you wanted to?" Dependent variables examined were age, marital status, language spoken at home, education, current tobacco and alcohol consumption, age at first sexual intercourse, whether

taking medication for cardiovascular disease, and presence of diabetes.

### Statistical analysis

Prevalence estimates of study variables were weighted for the probability of household selection (households with more phone lines were more likely to be contacted) and to adjust for the probability of selection within a household (men living in a household with more eligible men were less likely to be selected). Data were then weighted to match the Australian male population on the basis of age and area of residence based on estimates taken from the 2001 Australian Census.<sup>12</sup> Data was analysed using SPSS version 12.

Key demographic variables and other variables previously shown to be associated with erectile dysfunction were examined using Pearson  $\chi^2$  tests. Variables found to be associated with erectile dysfunction on univariate analyses were further entered into a logistic regression model in order to adjust for potential confounding factors. In the logistic regression analysis all variables were entered in one step and removed from the model according to the tolerance statistic (fitting the model using the "enter" criteria in SPSS for Windows 12.0). Adjusted odds ratios with their 95% confidence intervals (CI) were then calculated.

### RESULTS

A total of 8517 men (83.7%) reported being sexually active in the previous 12 months. Of these, 8367 (98.2%) responded to the question concerning erectile dysfunction. The mean age of this group was 37 years. Over half (56.7%) of the respondents were married, 8.4% were separated or divorced, and 34.5% had never married. Most respondents were in full-time employment (74.2%), 10% worked part-time and 4.7% were unemployed. The majority (94.3%) spoke English at home. Half (50%) had finished secondary or vocational education, and a quarter of respondents had completed some form of post-secondary education.

Almost one in 10 of the respondents (9.1%) reported that they had trouble keeping an erection when they wanted to, a difficulty which lasted for at least one month over the previous year. Over a quarter (27.2%) of respondents were current smokers, with 20.9% smoking  $\leq 20$  cigarettes per day and 6.3% smoking  $> 20$  cigarettes per day.

On univariate analysis, smoking was found to be significantly associated with erectile dysfunction ( $\chi^2 = 17.45$ ,  $df = 2$ ,  $p < 0.001$ ). Erectile dysfunction was also associated with a number of demographic characteristics including age, marital status and education level. No association was found between erectile dysfunction and either language spoken at home or age at first intercourse. People with diabetes or taking medication for cardiovascular disease were also significantly associated with erectile dysfunction with unadjusted odds ratios of 1.57 (95% CI 1.18 to 2.07) or 3.85 (95% CI 3.14 to 4.71), respectively. In contrast, moderate alcohol consumption (1–4 drinks per day) reduced unadjusted odds ratios of having erectile dysfunction.

Results of multivariate analysis are presented in table 1. Age remained a significant factor after adjusting for the other variables, with a fivefold difference in adjusted odds ratios of having erectile dysfunction between the youngest and oldest age groups. Respondents who had completed secondary or vocational education were less likely to experience erectile dysfunction than those with a lower level of education (adjusted odds ratio 0.76, 95% CI 0.64 to 0.92), but it was not the case for those having completed post-secondary education. Moderate alcohol consumption (1–4 drinks a day) retained significance as an independent factor for erectile dysfunction in the multivariate analysis (adjusted odds ratio 0.36, 95% CI 0.28 to 0.45). Respondents taking medications

for cardiovascular disease and those with diabetes were more likely to experience erectile dysfunction. However, only cardiovascular medication remained significant after adjustment for other variables.

Smoking was significantly associated with erectile dysfunction after adjusting for potential confounding factors. This association was strengthened as the number of cigarettes smoked increased. Compared with non-smokers, the adjusted odds ratios for erectile dysfunction were 1.24 (95% CI 1.01 to 1.52,  $p = 0.04$ ) for those smoking  $\leq 20$  cigarettes per day and 1.39 (95% CI 1.05 to 1.83,  $p = 0.02$ ) for those smoking  $> 20$  cigarettes per day.

### DISCUSSION

Our findings from a survey of a large representative sample of Australian men indicate that current smoking is significantly associated with erectile dysfunction and this association was strengthened as the number of cigarettes smoked increased. This finding is in keeping with a small number of previous population-based studies which provided some evidence of the relationship between erectile dysfunction and tobacco exposure levels. For example, the Massachusetts Male Aging Study<sup>9</sup> found that passive exposure to cigarette smoke at both at home and work doubled the odds of incident erectile dysfunction (adjusted odds ratio 2.07, 95% CI 1.04 to 4.13), whereas exposure within either setting did not. However, the authors did not examine the relationship between amount smoked and erectile dysfunction in current smokers. Gades *et al*<sup>13</sup> examined the relationship between cumulative exposure (pack-years based on reported duration and intensity of smoking) and erectile dysfunction in 2115 randomly selected white men in Minnesota aged 40–79 years. The odds ratios for erectile dysfunction in men smoking 1–12.5 pack-years, 12.6–29.0 pack-years and  $> 29$  pack-years after adjusting for age and co-morbidities were 0.96, 1.44 and 1.60, respectively. However, odds ratios were not statistically significant in those men with low and moderate cumulative exposure and findings from a trend analysis were not reported. Neither years smoked nor cigarettes smoked daily were significant predictors of impotence in current smokers in the Vietnam Experience Study.<sup>10</sup> This could be due to the limitation of its study population.

Our findings confirm previous research which has shown that erectile dysfunction to be an age-related condition that is more common in men with cardiovascular disease and/or diabetes,<sup>8, 14</sup> although the latter did not retain significance in our study, after other factors were controlled for. This may be explained by the fact that our relatively young, population-based sample (age 16–59 years) is likely to have included fewer and less severe cases of diabetes than previous studies. Modest alcohol intake appeared to confer an inverse relationship with erectile dysfunction in our respondents. This finding is consistent with the assertion that the risk factor profile for erectile dysfunction is similar to that for coronary heart disease. For example, the Massachusetts Male Aging Study found that overweight, hypertension and low physical activity levels were risk factors for erectile dysfunction.<sup>9</sup> We were unable to control for these additional risk factors in our analysis, which are unlikely to be distributed equally within our sample. This may explain why better educated respondents were less likely to experience erectile dysfunction than those who did not complete secondary school.

### Strengths and weaknesses

This study provides strong evidence of a relationship between levels of tobacco exposure in current smokers and erectile dysfunction. The significance of this finding is strengthened by the fact that our sample included men from a wide age range and that we were able to control for many of the

**Table 1** Association between tobacco consumption and erectile dysfunction

Study variables	Characteristics of study population weighted %	Having had erectile dysfunction				
		%	Unadjusted OR (95% CI)	p Value	Adjusted OR (95% CI)*	p Value
Tobacco consumption						
Non-smoker	72.8	8.8	1	0.43	1	
≤20 cigarettes per day	20.9	9.4	0.93 (0.54 to 1.32)	<0.001	1.24 (1.01 to 1.52)	0.04
>20 cigarettes per day	6.3	14.7	1.67 (1.11 to 1.97)		1.39 (1.05 to 1.83)	0.02
Age (years)						
16–19	5.7	4.6	1	0.85	1	
20–29	23.8	4.3	0.95 (0.59 to 1.55)	0.61	1.02 (0.62 to 1.68)	0.94
30–39	26.7	5.1	1.13 (0.71 to 1.81)	<0.001	1.32 (0.80 to 2.18)	0.28
40–49	24.8	12.4	2.97 (1.89 to 4.67)	<0.001	3.50 (2.15 to 5.70)	<0.001
50–59	19.1	20.7	5.49 (3.51 to 8.60)		5.96 (3.66 to 9.70)	<0.001
Employment						
Full time	74.2	9.6	1	0.57	1	
Part time	10.0	10.3	1.07 (0.85 to 1.36)	0.02	1.10 (0.86 to 1.42)	0.45
Unemployed	4.7	13.2	1.42 (1.05 to 1.93)	0.15	1.45 (1.04 to 2.01)	0.03
Other	10.0	8.1	0.83 (0.65 to 1.07)		0.67 (0.51 to 0.88)	0.004
Education level						
Pre-secondary	25.5	12.5	1	<0.001	1	
Secondary/vocational	50.0	8.3	0.63 (0.53 to 0.74)	0.002	0.76 (0.64 to 0.92)	0.003
Post-secondary	24.5	9.5	0.73 (0.60 to 0.89)		0.89 (0.72 to 1.10)	0.29
Alcohol consumption						
Non-drinker	10.3	18.2	1	<0.001	1	
1–4 drinks per day	78.7	8.6	0.42 (0.34 to 0.53)	0.15	0.36 (0.28 to 0.45)	<0.001
4+ drinks per day	11.1	15.5	0.83 (0.78 to 1.34)		0.89 (0.81 to 1.34)	0.20
Taking meds for CVD						
No	93.2	8.4	1	<0.001	1	
Yes	6.8	26.1	3.85 (3.14 to 4.71)		2.25 (1.80 to 2.81)	<0.001
Diabetes						
No	98.0	9.4	1	0.002	1	
Yes	2.0	24.5	1.57 (1.18 to 2.07)		1.22 (0.85 to 1.75)	0.28

\*Adjusting other variables in the table.

CI, confidence interval; CVD, cardiovascular disease; OR odds ratio.

established risk factors for erectile dysfunction, including age, co-morbidities and alcohol use. However, we acknowledge the need to exercise caution in making inferences about causality based on cross-sectional surveys of this kind. The association found in this study between smoking and erectile dysfunction warrants further investigation to establish whether this relationship is causal.

A single-item, self-reported measure was employed to assess erectile dysfunction over the previous 12 months. The breadth of issues covered in the ASHR meant it was not feasible to ask more than one question in relation to erectile dysfunction. However, the question used conforms to the US National Institutes of Health definition of impotence—that is, an inability to achieve or maintain an erection sufficient for satisfactory sexual performance.<sup>15</sup> Previous work suggests that questionnaires with one or two measures of erectile dysfunction correlate well with more detailed self-assessment tools.<sup>16–17</sup> Moreover, we employed a similar methodology and found broadly similar age-related prevalence figures for erectile dysfunction to those reported previously in large scale sexual health surveys conducted in the United States and Britain.<sup>18–19</sup>

Respondents who were not sexually active over the past 12 months (that is, had no sexual partners and did not masturbate) were not asked about erectile dysfunction (16.3% of the sample). It is possible that this may have been a source of selection bias in our study, given that we were unable to ascertain the prevalence and other determinants of erectile dysfunction in this group. Some of these men may have been sexually inactive because of erectile difficulties. However, bias due to the necessary exclusion of this group is likely to be minimal, as one third (33%) of sexually inactive men in the ASHR were aged 16–19 years (among whom erectile dysfunction is uncommon). The prevalence of the other main risk factors for erectile dysfunction (smoking,

alcohol use, cardiovascular disease and diabetes) was broadly similar in the sexually active and inactive group.

### Policy implications

Erectile dysfunction is an important public health issue in Australia affecting around one million men.<sup>20</sup> The prevalence of erectile dysfunction and the proportion of men who seek treatment for it is bound to increase given the combined impacts of an ageing population, increasing social acceptability of the condition and therapeutic advances. The already considerable healthcare costs associated with the management of erectile dysfunction, which grew substantially in a number of countries after the introduction of sildenafil and related drugs,<sup>21</sup> are likely to increase further. It is essential that available opportunities for prevention are acted on, such as reducing the number of men who smoke.

### What this paper adds

Studies on smoking and erectile dysfunction have been documented, often with the limitations of small or selective samples. This study used a large, representative and relatively young general population, and found a significant association between smoking and erectile dysfunction. In particular, this association was strengthened as the number of cigarettes smoked increased. The association found in this study between smoking and erectile dysfunction warrants further investigation to establish whether this relationship is causal. Increasing awareness about the link between smoking and erectile dysfunction in combination with other strategies may increase motivation for more young men to quit smoking.

Australia has one of the world's most comprehensive tobacco control strategies which is reflected in our relatively low smoking rates.<sup>22</sup> However, to meet the ambitious targets set by some states for further reductions—for example, a 1% annual reduction in prevalence in the most populous state, New South Wales<sup>23</sup>—will require more effective targeting of high-risk groups. Younger men (aged 16–44 years) are more likely to smoke than other groups yet may be least likely to change their behaviour in response to conventional tobacco control approaches. Increasing awareness about the link between smoking and erectile dysfunction in combination with other strategies may increase motivation for more young men to quit smoking. Lower levels of smoking would probably result in a reduction of prevalence of erectile dysfunction which affects about one million men in Australia.

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